UDC 347.77:629.78
DOI: 10.32518/sals1.2025.263

Соціально-правові студії. 2025. Т. 8, № 1
Social & Legal Studios. 2025. Vol. 8, No. 1

Legal analysis of the global space agencies and private companies engaged in space services

Gulmira Ishkibayeva
PhD, Researcher
Zhetysu University named after I. Zhansugurov
040009, 187A Zhansugurov Str., Taldykorgan, Republic of Kazakhstan
https://orcid.org/0000-0002-7021-5627

Daniya Nurmukhan kyzy*
PhD, Associate Professor
Zhetysu University named after I. Zhansugurov
040009, 187A Zhansugurov Str., Taldykorgan, Republic of Kazakhstan
https://orcid.org/0000-0003-3817-1975

Galym Teleuyev
PhD, Dean of the Faculty Law and Economic
Zhetysu University named after I. Zhansugurov
040009, 187A Zhansugurov Str., Taldykorgan, Republic of Kazakhstan
https://orcid.org/0000-0001-9575-5278

Dana Baitukayeva
PhD, Senior Lecturer
Al-Farabi Kazakh National University
050040, Al-Farabi Ave., 75, Almaty, Republic of Kazakhstan
https://orcid.org/0000-0002-8564-7027

Abstract. The study aimed to analyse international legislation in the space industry and the legislation of the Republic of Kazakhstan, as well as to establish the legal framework for the activities of private entities and international space agencies. For an effective study of the topic, terminological, hermeneutical, comparative, and historical methods were used in the study. The study described the commercialisation of space technologies and space in general, identifying current problems and prospects. In particular, the article studies the issue of knowledge transfer and identifies the key role of international cooperation in this transfer. The main international regulatory framework in the field of space activities was also analysed. The legal basis for the activities of leading international space agencies (National Aeronautics and Space Administration and European Space Agency), private companies (Space Exploration Technologies Corporation and Blue Origin), as well as the space committee of Kazakhstan – Aerospace committee of the Ministry of Digital Development, Innovations and Aerospace Industry of the Republic of Kazakhstan was established. The study identified the guiding principles for the activities of public and private institutions established by international space law (exploration of outer space and use of its objects for peaceful purposes, prohibition of appropriation of celestial bodies, non-discrimination, etc.). The study highlighted the need to ensure international cooperation. This concerns cooperation between the public and private sectors in the implementation of common space goals and objectives to increase the potential of space technologies. The study also emphasises the importance of states' compliance with treaties on outer space activities, as well as their harmonisation with national legal acts

Keywords: 3D orbital launches; international regulatory framework; satellite; celestial bodies; technology commercialisation

Suggested Citation

Ishkibayeva, G., Nurmukhan kyzy, D., Teleuyev, G., & Baitukayeva, D. (2025). Legal analysis of the global space agencies and private companies engaged in space services. *Social & Legal Studios*, 8(1), 263-277. doi: 10.32518/sals1.2025.263.

Article's History: Received: 18.11.2024 Revised: 17.02.2025 Accepted: 26.03.2025

*Corresponding author

Introduction

Given the rapid development of the space sector, the relevance of the legal analysis of the activities of global space agencies and private companies providing space services remains particularly high. The increased involvement of the private sector, in particular Space Exploration Technologies Corp (SpaceX) and Blue Origin, along with government agencies, has led to significant changes in the exploration and commercialisation of outer space. This process raises important legal issues regarding ownership of outer space, international responsibility, and compliance with existing treaties, including the Outer Space Treaty. Given the growing role of developing countries, such as Kazakhstan, in the global space arena, the study of the legal framework is key to sustainable development and cooperation in the international arena.

C. Wang and J. Wang (2024) conducted an in-depth analysis of the regulatory framework for the commercial use of space resources, addressing the international legal framework and the American legislation. The authors identified weaknesses in China's current legislation and suggested improvements, following the international best practices. In particular, the study identified the need for more comprehensive legislative measures to support China's development in this area. The study focused on stimulating a steady and systematic increase in China's commercial activities in the field of space exploration through improved legislation and international cooperation.

P. Brady and J. Orlinksi (2022) assessed public opinion on the functioning of private space companies. The researchers found that most people are in favour of space exploration and moderate government control over the activities of these companies. In addition, the authors found support for large-scale satellite systems such as SpaceX's Starlink, despite awareness of the risks associated with them. In general, the survey results show that the population has a favourable perception of private space companies and their activities that contribute to the expansion of space exploration.

A. Salykov *et al.* (2024) studied the peculiarities of the space industry of Kazakhstan in the context of the digital economy transformation. The authors outlined the main factors that influence the development of the industry, including the existence of strategic cooperation and technological development. At the same time, the researchers determined that traditional industries generate internal value, while the digital economy generates it through external cooperation between suppliers and consumers. The study argued that the innovative development of Kazakhstan's space sector requires a shift away from a "rental" approach to the formation of international relations of strategic cooperation. In particular, the researchers shared ideas to help develop policies that combine digital economic strategies with space industry development initiatives in Kazakhstan.

N. Ruhaeni *et al.* (2022) analysed how the Outer Space Treaty supports the commercialisation of outer space and its impact on the development of Indonesia's space industry (Treaty on Principles…, 1966). The researchers determined that, despite indirectly permitting commercial activities, the Treaty does not provide for specific regulation of such activities. The authors emphasised that the absence of such regulations requires additional legal development to stimulate the growth of the rapidly developing space industry in Indonesia. The study highlighted the opportunities and challenges of aligning international law with national interests in the space industry in terms of commercial activities.

F. Viterale (2023) conducted a comprehensive systemic analysis of the 21st century space, emphasising the complex structure of interactions and their use. The author identified a transition to a multipolar system with more active intervention by state and non-state actors. The study notes that, despite the key role of government agencies, private companies have a significant impact on space activities. At the same time, the study highlighted the lack of effective international governance in space, despite efforts to create appropriate rules and standards. J.-C. Le Coze (2024) examined the security situation in the relationship between the National Aeronautics and Space Administration (NASA) and SpaceX, highlighting the role of bureaucracy in the space industry. The author examined previous approaches and questioned current practices, based on the findings of H.E. McCurdy (2002, 2013). The study notes that cooperation between the public and private sectors will help improve safety standards by adapting to regulatory changes in space. J.-C. Le Coze (2024) emphasised the need to create flexible bureaucratic mechanisms to guarantee effective security measures in space research.

Although substantial academic research in the field of international space law is present, there is still a gap in a comprehensive legal analysis that includes the activities of government agencies along with private companies. Previous studies analysed the public and private sectors separately. A rather small number of studies deal directly with the legal regulation of these institutions. This study aimed to analyse the international regulatory framework in the field of space activities and to establish the legal basis for the activities of space agencies and private companies in the space industry. The main objectives of this study were:

1) to identify the main international treaties in the field of space activities and analyse their provisions;

2) to study the legal aspects of space technology commercialisation and knowledge transfer, in particular, to identify their challenges and prospects;

3) to analyse the legal regulation of the activities of leading space agencies and private companies in the space sector.

Materials and methods

To study the issue of legal regulation of the activities of global space agencies and private companies in the field of space, primarily used international experience in general. This helped to establish the legal basis for space activities in the international arena and pointed to the importance of compliance with international principles by these institutions, regardless of their country of establishment. In particular, the space experience of a single country, namely Kazakhstan, was used, which was chosen as an example of a country whose space industry is developing rapidly and needs to be studied in a more global context. The terminological method was used to interpret and analyse the regulations, which helped to explore the concepts and content of outer space and the commercialisation of space technologies (space). The use of hermeneutics in the study established the meaning of these definitions and considered them in the context of a broader legal discourse. This was used to study the application of the concepts in international jurisdiction and the jurisdiction of Kazakhstan.

In the course of the study of legal acts, the provisions of the following fundamental documents in the space sphere were analysed: The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (OST) (1966); Convention on International Liability for Damage Caused by Space Objects" (Liability Convention (LC)) (1971); and Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (RA) (1967). In particular, the key space treaties analysed include the Convention on Registration of Objects Launched into Outer Space (RC) (1974) and the Agreement Governing the Activities of States No. 34/68 "On the Moon and Other Celestial Bodies" (MA) (1979). The Article also examines the provisions of the U.S. Commercial Space Launch Competitiveness Act (CSLCA) (2015), which regulates commercial spaceflight.

The National Aeronautics and Space Act of 1958 (NASA Act) (1958) was used to study NASA's activities; while the Convention for the establishment of a European Space Agency (CESA) (1975) was used to study the European Space Agency (ESA). In turn, the cooperation of the leading private space companies SpaceX and Blue Origin with NASA is determined by the Nonreimbursable Space Act agreement between NASA and SpaceX for flight safety coordination with NASA assets (NCAA) (2021) and the Unfunded Space Act Agreement between the National Aeronautics and Space Administration and Blue Origin of 2022 (USAA) (2022), respectively. To study the legislation of Kazakhstan in the field of space, the Law of the Republic of Kazakhstan No. 528-IV "On Space Activity" (2012) was used.

An important place in the study was occupied by the comparative method, which allowed comparing the provisions of regulatory legal acts in the space sector concerning the guiding principles of activity beyond the Earth (peaceful purposes, prohibition of appropriation of space objects, non-discrimination, etc.) The study also used the historical method to analyse the space activities of international space agencies and private companies. In particular, the study analysed Space Stats (n.d.) statistics on orbital launches by China, India, Iran, Japan, the United States, Russia, and North Korea.

Results

International legal regulation of space activities and technology transfer. The fundamental legal acts mentioned in the methodology contain guidelines and principles for the activities of agencies and companies (both governmental and private) in outer space regarding space exploration and exploitation (Zhao, 2018). This statement is supported by the provisions of Articles 2-4 of the OST (1966), which establish that this legal act is the foundation for space law, which guarantees the obligation of states to peacefully explore outer space and the prohibition of appropriation of any celestial bodies. Of particular importance is Article 4 of the OST (1966), which establishes an international ban on the placement of nuclear weapons or weapons that pose a threat to humanity in orbit around the Earth and outer space in general. In addition, this Article prohibits the formation of military units and devices, testing of various weapons systems, as well as military exercises on celestial bodies. However, it is also noted that there is no prohibition on the use of the military in peaceful research and the installation of facilities, again, for the peaceful exploration of the Moon and other celestial bodies.

According to Article 5 of the OST (1966), an astronaut is an envoy of all mankind to near-Earth space. In the event of a hazardous situation, the signatories to the Treaty are obliged to assist these representatives. This Article obliges states to report identified aspects that potentially pose a hazard in space. Whereas Articles 7 and 8 of the OST deal with legal liability for damage in outer space and stipulate those states should be liable for damage caused by their astronauts or space technologies (Article 7 of the OST). Whereas Article 8 of the OST states that the signatory state continues to exercise jurisdiction and control over the object it has launched and the crew on board in outer space.

RA (1967), in turn, builds on the principles set out in Article 5 of OST (1966) and is responsible for ensuring the interaction of international society in emergencies arising from space activities, but contrary to the principles of Article 5, it provides more detailed recommendations for their practical implementation. Thus, Article 1 of the RA establishes the obligation of states that are informed of a dangerous situation that has occurred with the crew of a spacecraft in space to immediately notify the launching authority and the UN Secretary-General. This allows for timely notification to facilitate rescue efforts. Whereas Article 2 of the RA requires that contracting parties immediately search for and rescue the personnel of a spacecraft that has made an emergency or emergency landing on the territory of their state.

The LC (1971) is of great importance for the safe implementation of space activities, as Article 2 of the LC provides that the launching state must fully compensate for damage caused by its space object on the Earth's surface or in the flight of a spacecraft. If the damage is caused directly in outer space, the state should be liable only if such damage was caused by its fault (as provided for in Article 3 of the LC). Thus, these provisions provide for a specific procedure for eliminating losses and imposing liability in the event of space accidents caused by malfunctions of space technologies or humans in space. Article 8 of the LC establishes that if a state suffers damage during space activities from another state and its representatives, such state may file a compensation claim. This claim must be filed no later than one year after the damage was caused or the offending state was identified (as provided for in Article 10 of the LC). If the dispute is not settled amicably within the specified period, a commission on the damage claim is formed (Article 14 of the LC).

Article 2 of the RC (1974) stipulates that all objects launched into space must be registered with government authorities and the international registry maintained by the United Nations (UN) Secretary-General. In particular, Article 4 of the RC defines the list of data on the space object required for registration:

- name of the launching state(s);
- acceptable identification designation of the space object or its registration number;
- data on the place and date of launch or location of the space object;
- orbital parameters, including initial period, inclination, apogee, and perigee;
- main functions of the object. In general, the LC provisions improve the level of transparency regarding the ownership and purpose of the objects that are launched.

The MA (1979) contains important provisions governing space activities on the Moon and other celestial bodies, according to Article 1, the provisions of the Agreement apply

not only to the Moon but also to any other celestial body within the Solar System. Article 3 of the MA states that the Moon shall be used only for peaceful purposes and prohibits any military use of the Moon and the placement of nuclear weapons on it. Article 6 ensures the free conduct of scientific research without any inequality between the signatory states. Article 7 of the MA focuses on the prevention of environmental pollution through preventive measures. Whereas Article 11 of the MA refers to the introduction of an international regime for the rational use of the Moon's resources based on equal access to them by all states. In general, analysing the provisions of the MA articles, it was established that it is a fundamental treaty in the field of space activities. Firstly, this is determined by the fact that these articles contain the principles of peaceful and equitable use of celestial bodies, which guarantee the benefits of space exploration for all states.

Together, these international treaties provide a favourable legal environment for peaceful space exploration, while holding states engaged in commercial activities accountable. They emphasise the principles of not appropriating space objects, but at the same time allowing private companies under the control of states to participate in commercial projects (launching satellites or mining natural resources on celestial bodies (asteroids)). Although these major outer space treaties do not contain specific provisions on technology transfer, they establish guiding principles based on which such transfer should be conducted. This applies to the principle of cooperation, which, in turn, extends to technology transfer and facilitates it, etc. Despite the existence of an extensive legal framework for space activities, there is no comprehensive framework specifically regulating the transfer of space technologies. In the practical implementation of space programmes, states use a variety of tools, including research and development collaborations between state institutions and private companies. This facilitates the exchange of experience and technology but is also consistent with the principles of international law.

Commercialisation of space technologies and knowledge transfer: Legal aspects. Despite an extensive regulatory framework in the space sector, international treaties do not contain a provision defining the concept of commercialisation of space technologies (space). However, they do have certain provisions that help to establish the essence of this phenomenon. Article 1 of the OST (1966) stipulates that any exploration of outer space should be carried out exclusively for the benefit of all states of the world, and not in the interests of a particular state or region. It also establishes the prohibition of discrimination and the importance of ensuring equal access to space research by states (including their public authorities and private enterprises). While Article 6 of the OST states the activities of both governmental and non-governmental organisations. However, at the same time, it contains a provision on the state's obligation to grant permission and further monitor the space activities of such non-governmental institutions (Jagota, 2023).

Thus, the commercialisation of space involves the involvement of the private sector in space research by the state, based on the principle of non-discrimination, free conduct of scientific research, and prevention of the seizure of outer space objects. This, in turn, is implemented using innovative space technology, infrastructure and materials (Space commercialization, n.d.; Moltz, 2019). This involvement was central in the development of space technology and space exploration in general, as it attracted billions of dollars from non-governmental organisations and entrepreneurs (Atkins, 2022).

According to the Space Foundation's 2024 report, over the past 10 years, the average annual share of the European private sector in the space industry has increased by 66% (Space Foundation Editorial Team, 2024). Such commercialisation covers various areas of activity that are an integral part of space activities, including resource extraction (including asteroids), space tourism, development of commercial satellites and their launch, construction of reusable rocket facilities (such as SpaceX), various space exploration activities, etc (Kaneria & Pandey, 2024). Overall, the creation of a stable and profitable space industry that will effectively implement the latest space technologies to support economic development is the main objective of space commercialisation. By reducing costs and making space more accessible, private enterprises can offer services that will be useful in various industrial sectors, such as telecommunications and agriculture (e.g., satellite launches and remote sensing) (Apakhayev *et al.*, 2018; Fedonyuk *et al.*, 2020). In addition, competition stimulates innovation, which helps to improve technological advances that were previously unavailable. Space commercialisation also ensures the long-term preservation of human presence in space (Serikzhanova *et al.*, 2024). This is done by developing the necessary materials and resources for long-distance space missions.

Speaking directly about knowledge transfer, the Organisation for Economic Co-operation and Development (OECD) in its publication established the essence of space technology transfer and commercialisation (TTCs), which includes this concept. Thus, TTCS is the process of transferring experience, skills, professional and technical knowledge, expertise, various techniques, and innovations from one governmental institution (in particular, a space agency) to another. As a result of this transfer, economic development beyond the space industry is ensured and its value is formed. The OECD's identification of ways to transfer knowledge and technology to the space sector was important, including: commercialisation of national intellectual property through patenting or establishment of enterprises; cooperation in research (including involvement of scientists or private entities in state-targeted research); publication of scientific articles, exchange of personnel, organisation and holding of scientific conferences, allocation of resources and equipment, etc. Thus, the OECD has combined knowledge transfer and commercialisation of space technologies and established their inextricable interconnection (Olivari *et al.,* 2021).

The transfer of experience and skills is an important component of space commercialisation and is enshrined at the international level. Notably, part 3 of Article 1 of the OST (1966) establishes the importance and necessity of cooperation in the international community on space exploration (a similar provision on cooperation is contained in Article 3 of the OST). Another example of the importance of transferring knowledge and skills between states (including the private sector) is enshrined in law in Article 10 of the OST. It provides for the authorisation of states to supervise the launch and flight of near-Earth objects launched by other states.

Lastly, the issue of legal aspects related to space commercialisation and knowledge sharing is the need to overcome complex legislative regulation at the national and

international levels. This will help ensure cooperation between government agencies and the private sector. At the same time, it will facilitate successful cooperation and address potential challenges that threaten the protection of intellectual property and liability for infringement.

Legal nature of space technologies and their commercialisation: Challenges and prospects. The UN defines space technologies as developments that enable various space operations, including communication and navigation via satellites, Earth monitoring, and the exploration of outer space beyond Earth orbit using robotics and human participation. The UN also stressed that such technologies are mostly created and implemented by public and private enterprises, as well as space agencies (Space technologies and…, n.d.).

A significant gap in international space legislation is the lack of a definition of space technologies. In general, this gives space law entities the ability to expand the nature and capabilities of these technologies. But, at the same time, it causes legal challenges in the field of intellectual property (IP) law and the problem of potential misappropriation of space objects. First, this is due to the unspecified list of technologies that can be used for space exploration. Since, given the different characteristics and tasks of certain technologies, some can be used for observation or space tourism, while others are created for mining space resources (e.g., asteroids). This, in turn, directly contradicts the provisions of space law, which prohibits the appropriation of any space resources or objects (Article 2 of the OST (1966)). At the same time, this creates a contradiction between technological advances in recent decades and legislation, as it raises a legal issue regarding the ownership of extracted resources or certain discoveries.

The insufficient level of development of national legal norms on patent law governing the use of inventions resulting from space activities remains an urgent problem. Uncertainty in the legislation on the ownership of space technologies negatively affects the involvement of potential private enterprises in the commercialisation of outer space (Abeyratne, 2011). At the same time, the absence of IP provisions in international space legislation causes difficulties in interpreting the extension of the national legal framework to registered space objects outside the Earth's atmosphere. This absence hinders the attraction of large-scale investments in space research and development activities and the latest developments, as investors do not have a reliable legal protection mechanism for innovative developments (Gangmeih & Mishra, 2024).

For the successful cooperation of the public and private sectors in space commercialisation, it is crucial to ensure proper protection of their IP. This is the main prospect for the development of space technologies and their commercialisation, as the presence of a clear legal framework will protect the copyright of inventors and stimulate investment in the space industry. This approach will promote the introduction of the latest technologies and contribute to economic development, as well as help to avoid conflict situations and ensure sustainable development for the entire international community (Inventions in space, n.d., Usulor, 2023).

J. George (2024) identified the transition of space commercialisation to a sustainable operation as an important step for the further development of space commercialisation. J. George argued that the space sector is developing with increasing rates, but significant efforts are needed to make it sustainable. This development is supported by the receipt of USD 433 billion in funding for space programmes, but there is a prospect of increasing this amount to USD 1 trillion over the next 10 years. This will be realised through government assistance in attracting the private sector along with its investments and innovations.

Technologies and their continuous improvements are crucial for space commercialisation, as demonstrated by the large-scale technological progress in the space sector (Barikova, 2023). For example, the use of reusable rockets has drastically reduced the cost of launching them, which has made it more affordable to launch satellites and conduct other space missions (Hall, 2024). Figure 1 shows the data on orbital launches that took place in 2024. Innovations, such as mega-rocket technology, will contribute to future capacity expansion by enabling the use of more payloads at lower costs. Such innovations will allow for an expanded range of services, including satellite construction, communications, and cargo delivery beyond Earth orbit (Khlystov & Markovitz, 2024).

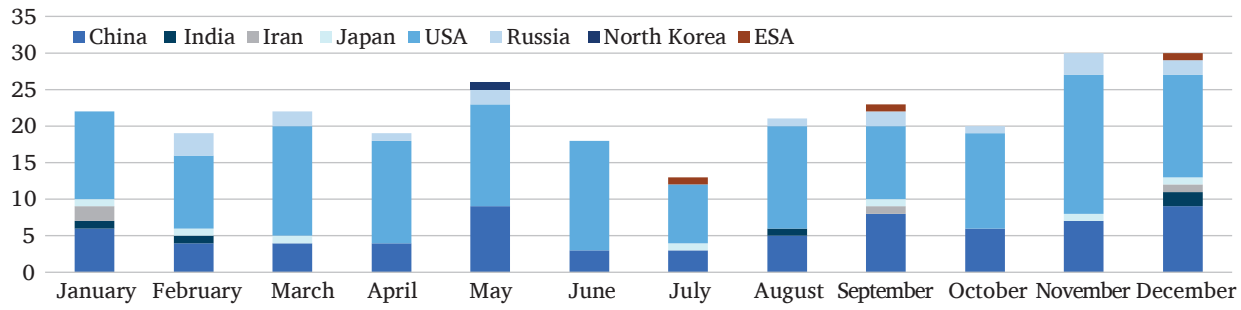

Figure 1. Orbital launches in 2024

Source: compiled by the authors based on Space Stats (n.d.)

Figure 1 shows the orbital rocket launches for the period of 2024, with the participation of China, India, Iran, Japan, the United States, Russia, North Korea, and the European representative ESA (ESA is indicated in the figure because some European countries did not carry out launches, but they were carried out by ESA as a representative of European states). According to Space Stats (n.d.), a total of 263 launches took place, of which 254 achieved their goal and were successful, partial failure occurred in three cases, while total failure occurred in six cases. As can be seen from the figure, the United States made the most orbital launch attempts in 2024, while North Korea made the fewest. At the same time, Figure 2 shows the evolution of orbital launches from 1957 to 2025.

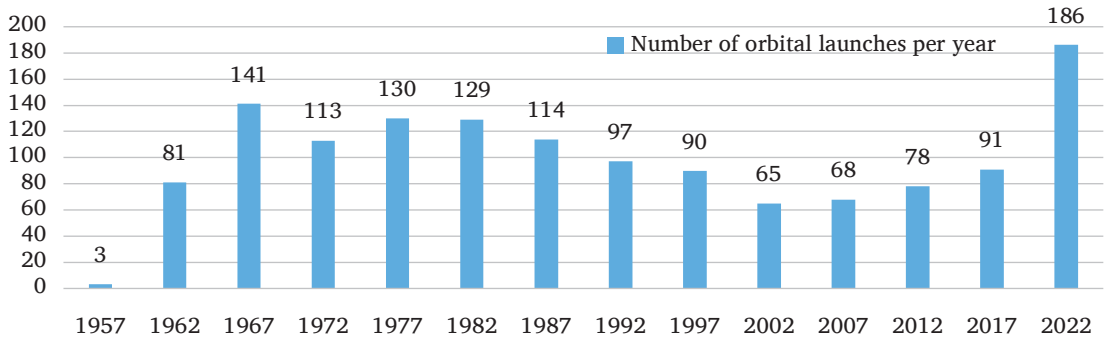

Figure 1. Orbital launches for 1957-2022
Source: compiled by the authors based on Space Stats (n.d.)

Thus, Figure 2 shows the evolution of the growth in the number of orbital launches over 65 years, with the number of launches studied every 5 years from 1957 to 2022. Figure 2 demonstrates that over the period from 1962 to 2017, the total number of launches varied at a relatively constant level without significant ups and downs. In contrast to the surge in activity in 2022, when the number of launches into space reached 186, and compared to the data in Figure 1, which examined orbital launches in 2024 (263 launches), this surge in activity continues (Space Stats, n.d.). In general, successful space commercialisation requires international cooperation, and this is especially true for cooperation between the public and private sectors. In particular, the establishment of a clear legal framework for IP law and the definition of space technologies at the international legislative level is essential to attract new investors in space exploration.

Legal analysis of the activities of World Space Agencies. As a result of the development of space technologies and the changing legal framework, the activities of international space agencies and private entities have undergone significant transformations. There has been an increase in cooperation between government agencies, such as NASA and ESA, and private companies, such as SpaceX and Blue Origin. The regulatory framework governing activities in this area is comprehensive and is determined by international treaties, particularly the OST (1966). At the same time, the development of outer space beyond Earth's orbit is accompanied by challenges arising from liability for incidents and the distribution of rights to use resources (Konert *et al.,* 2022).

Global space agencies, such as NASA and ESA, are central in space exploration, stimulating technological innovation and setting standards for international cooperation. While private companies are tasked with fostering entrepreneurial initiative and increasing the sector's productivity through the development of reusable rockets and lunar missions, which pushes the sector's horizons (Chudyk & Vivchar, 2023). Together, these entities create a cooperative atmosphere that promotes progress in space technology and, by pooling their resources and expertise, accelerates its development.

An important place in space exploration belongs to NASA, which operates on the basis of the NASA Act (1958), in particular, paragraph (c) of Article 101 of the NASA sets out the main goals and objectives to be fulfilled by NASA as a representative of the US space agency, including:

1) improving the quality, practicality, safety, power and efficiency of space and other aircraft;

2) organising comprehensive scientific research into the potential opportunities and challenges arising from space and aeronautical activities for peaceful and scientific purposes, as well as the possible benefits of such activities;

3) deepening public understanding of atmospheric and space phenomena;

4) maintaining the leading global position of the United States in the space and aviation industry, their implementation in peaceful functioning in the atmosphere and beyond;

5) creation and introduction of aircraft that allow transporting equipment, supplies, devices and living organisms into space;

6) adherence to the principle of maximum promotion of the development of scientific and engineering resources of the United States on the basis of cooperation of all involved US agencies to avoid unnecessary duplication of activities, equipment and resources;

7) promoting cooperation between the United States and other states in the conduct of research conducted under this Act and the use of the results of such research for peaceful purposes;

8) informing agencies directly related to national security of scientific discoveries of military importance.

This also includes providing important information to civilian organisations established to manage and regulate non-military space and aviation activities of the NASA Act (1958). Of particular importance for the activities of this Agency was the development and implementation of the Artemis Accords (2020), which formed a set of principles (non-binding) to strengthen the system of regulation of civilian space exploration and exploitation. At the same time, the preamble to the Artemis Accords emphasises the importance of signatory states' compliance with the basic regulatory legal acts in the field of outer space. Thus, the Agreement defines the some important guiding principles in space exploration. Peaceful intentions (set out in Article 3 of the Artemis Accords (2020)) all activities carried out under the Artemis programme must be aimed at achieving peaceful objectives, which is consistent with the requirements of the OST. This principle envisages cooperation between states in the peaceful exploration and development of outer space. The principle of transparency stipulates that signatory states guarantee transparency by making public their strategy and plans related to space activities. This includes the dissemination of scientific data to the public and the international scientific community – Article 4 of the Artemis Accords (2020). The principle of compatibility (Article 5 of the Artemis Accords (2020)) encourages the interaction of different systems used by governments and ensures reliable and effective cooperation based on international standards.

Article 6 of the Artemis Accords (2020) establishes the obligation to provide assistance to astronauts and other personnel in space when necessary, emphasising the importance of mutual assistance in difficult situations. The Register of Objects of Space Activities Launched into Earth Orbit is necessary to ensure safe and sustainable activities in space (Article 7 of the Artemis Accords (2020)). Article 8 of the Artemis Accords (2020) establishes the principle of dissemination of scientific research data, which requires free access to scientific information resulting from missions and access to scientific discoveries made during research related to the Artemis programmes. Protection of historical heritage sites and prevention of space debris (Articles 9 and 12 of the Artemis Accords (2020)). Article 10 of the Artemis Accords (2020) stipulates the importance of the extraction and exploitation of space resources for the safe and rational exploration of outer space. In addition, signatories must inform the UN Secretary-General, society and the scientific community about space resource extraction activities. The principle of prevention of negative impact and due respect, which is enshrined in Article 11 of the Artemis Accords (2020), in turn, helps to avoid conflict situations in outer space.

All principle also applies to the definition of "security zones" that are established between states and can be cancelled after the cessation of relevant activities (Lea, 2025). Taken together, these principles are intended to shape the responsible policy of states engaged in civil space activities. They are also intended to promote the development of international cooperation that is beneficial to all mankind through the dissemination of knowledge about resources and methods of their management that comply with current international standards.

ESA is the European representative of the space agency, which was the result of the signing and implementation of CESA. An important achievement of the agency was the expansion of its powers, as the implementation of operational systems for space use (e.g., telecommunication satellites) was added to the conduct of scientific space research and the launch of conventional rockets (Lindbergh, 2024). The purpose and objectives of ESA's activities are legally enshrined in Article 2 of CESA (1975), as the Agency must guarantee and encourage cooperation between European states in the field of scientific and technical space research. Emphasis is placed on the observance of peaceful purposes in the further use of research data for solving space problems. In particular, Article 2 of CESA (1975) identifies 4 main ways to help achieve these goals: development and implementation of programmes and measures on space activities; development and implementation of an appropriate industrial strategy compatible with its programme, as well as submission of proposals to the signatory states for a consistent industrial policy; formation and implementation of a common European space policy in the long term, through recommendations on space goals and coordination of state policies, addressing the interests of other international and national institutions; coordination of the national programme and space.

Of particular importance is Article 5(1) of the CESA (1975), which defines the mandatory and additional activities of the ESA. Thus, paragraph (a) sets out the activities that must be performed on a mandatory basis: maintaining documentation, conducting exercises and providing relevant education, developing promising projects and conducting technological research; accumulating and exchanging relevant information between the Agency's member states, identifying differences in the programmes developed, and advising on the harmonisation of international activities; establishing a constant dialogue with users to learn about their expectations and needs; formulating scientific programmes or strategies related to space systems and putting them into effect. Point (b) establishes additional ESA activities and allows the Agency to engage in operational programmes following the requirements set by the Council. This includes, inter alia, the provision of satellite launches capabilities or monitoring services, with the consent of users.

Thus, the mandatory activities envisaged in this Article play a key role in stimulating innovation and enhancing European competitiveness through the creation of a sustainable research base. While the optional activities are established mainly to incorporate the potential capabilities and space strategies of different states. Overall, the provisions of this Article provide a framework for balancing the unified objectives of the ESA with different national interests and capabilities, while at the same time contributing to strengthening cooperation between its members.

However, despite the effectiveness of the regulatory framework in the field of space activities, there is significant legal uncertainty regarding the commercial use of space resources. This uncertainty is due to the lack of clear international and national legal provisions governing the commercial use of space resources. First, this is because such use is a new phenomenon, especially concerning the extraction of asteroids and water on the Moon. Thus, due to technological progress and the constant development of commercial space exploration, existing space treaties contain outdated provisions that do not meet current challenges.

The main challenge in the field of space commercialisation is that the fundamental acts prohibit the appropriation of space resources and objects (in particular, Article 2 of the OST (1966)), while there is no clear provision for such appropriation by private institutions. This, in turn, creates a contradiction, since there is no clear indication that this prohibition applies to the private sector, but at the same time, the principle of non-appropriation of space resources and objects is in force. Another problem is that states have different interpretations of treaty provisions on the use of space resources. For instance, Article 1 of the OST allows the use of space resources by all states, while the United States interprets this principle as the possibility of resource extraction, if it is not a national appropriation (this interpretation is unclear and to some extent contradicts the Treaty) (Consonni *et al.,* 2023). A significant gap in the legislation on space activities is the absence of specific provisions regulating liability in case of damage to the natural environment or pollution and waste disposal during space resource extraction by both public and private entities (in particular, following Article 4 of the OST).

To bring space legislation in line with the progress in space activities and to address current challenges and legal uncertainties in this area, it is necessary to clarify the current provisions of the fundamental space treaties that determine the possibilities of commercial use of space resources (Ruhaeni *et al.,* 2022; Wang & Wang, 2024). Among other things, they establish liability for the harmful effects of resource extraction in space on the environment. There is a need to develop a special unified regulatory act that will

fully regulate the use and extraction of space resources by private institutions. It should also include provisions on such aspects of space commercialisation as ownership of space resources, their use and liability for environmental pollution during extraction of such resources. Harmonisation of national legislation on the exploitation of space resources is essential for effective space activities, as it will help to minimise legal uncertainties and enhance cooperation in the international arena.

Legal analysis of the activities of private companies engaged in the provision of space services. Particular attention is devoted to the space activities of private companies, which have several advantages over governmental organisations, the main one being their adaptability to the changing market of space services, thanks to innovation and technological progress. In the case of SpaceX and Blue Origin (which will be discussed further), they have proven to be cost-effective through the effective implementation of reusable rockets. This methodology minimises the cost of launching them, contrary to the standard disposable rockets used by government agencies. Private companies are also actively using venture capital investments to stimulate innovation and expansion into new markets, such as lunar exploration or satellite communications. The transition to privatisation in general contributes to increased productivity and progress in space exploration, as it encourages competition and supports a corporate approach in the space industry (Heitor *et al.,* 2024; Mayrhofer, 2024).

For instance, SpaceX is one of the most ambitious companies that directly designs, manufactures, and launches space technologies beyond Earth orbit. This company was founded in 2002 by E. Musk, with the slogan "to fundamentally change space technology to allow people to settle on other planets" (Momose *et al.,* 2023). SpaceX became the first private company to dock its spacecraft on the ISS in 2012 the development of the Dragon spacecraft and the Falcon 9 rocket launcher helped in this. While Blue Origin was founded in 2000 by J. Bezons and had as its primary goal – sending people into space. The focus of Blue Origin's activities is to put into practice commercial suborbital human space travel, which should contribute to the growth of the space tourism industry (Private companies are…, n.d.). An important achievement of the company was the development of the New Shepard vertical launch rocket (which can reach 100 km in height); after the descent, the rocket returns to Earth, and at the end of the flight, the engines are turned off, so that the spacecraft makes a vertical landing (Sylkina *et al.,* 2015; Pallathadka & Pallathadka, 2022).

The main legal act under which SpaceX and Blue Origin operate is the CSLCA (2015), which regulates commercial spaceflight. Article 103 of the CSLCA, which guarantees compensation for losses to participants in space flights, is of great importance for the activities of these companies. This Article extends insurance obligations and financial liability to participants in such flights until 30 September 2025 and directly applies to these private companies. Thus, the provision establishes a guarantee of liability for SpaceX and Blue Origin at the legislative level and covers the costs of insurance for flight participants (astronauts or tourists) in case of injury or death during a space flight.

Article 104 of the CSLCA (2015) provides for flexibility in the issuance of licences for space launches. This is implemented to ease regulatory pressure and stimulate innovation in the commercial space industry. This Article also allows private companies to obtain permits for experimental suborbital launches. In general, the provisions of Article 104 of the CSLCA help SpaceX and Blue Origin to accelerate the testing of the latest space technologies. It also allows companies to engage in research and development activities without the need to obtain a full licence, which, in turn, significantly simplifies the testing procedure and minimises costs.

Whereas Articles 106 and 107 of the CSLCA (2015) regulate the issues of legal liability and law in general in the field of space commercialisation. Both articles are aimed at creating conditions for a clear and consistent settlement of claims related to this area. Article 106 of the CSLCA establishes exhaustive federal jurisdiction, which provides for legal liability for offences committed during space commercialisation and relies on the competence of federal courts. In turn, Article 107 of the CSLCA deals with the issue of mutual waiver of claims or defences, as well as the determination of liability. This provides for the obligation of the parties (contractors, subcontractors, and consumers) to be liable for damage, whether bodily or property, including death, that occurs during a licensed space flight. Thus, these articles are highly relevant for the effective operation of SpaceX and Blue Origin, as they clearly define legal liability in the event of damage or an offence, establish which courts will potentially hear the dispute, and help to reduce financial risks.

Moreover, the NCAA (2021) regulates the powers and mechanisms for ensuring the safety of SpaceX's Starlink satellites and NASA-protected facilities. The purpose of the Agreement is to prevent collisions and maintain the safe operation of satellites in orbit in the absence of financial exchange between the parties (as provided for in Article 2 of the NCAA). Article 3 of the Agreement sets out the responsibilities of NASA and SpaceX, and their fulfilment is expected to ensure effective cooperation between these organisations, including provide SpaceX with clear and accurate information on assets for human spaceflight, which, in turn, are verified by means of a connection risk assessment analysis (CARA); in the event of an emergency change in satellite movement, it is necessary to provide at least 8 hours for this; provide SpaceX with ISS ephemeris files to develop mission planning and objectives; in the event that NASA needs to conduct an experimental manoeuvre after the mission, the Agency is obliged to contact SpaceX within 24 hours after the mission; share experience and technical developments with SpaceX to develop joint approaches to modernising the conjunction assessment procedure; notify SpaceX as soon as possible of changes in the NASA conjunction assessment system that may affect SpaceX activities; share knowledge on the development of new methods of observation and minimisation of photometric radiation brightness, etc.

The main obligations of SpaceX are to provide ephemeris to the 18th Space Control Squadron (SPCS) and NASA at least three times a day, which will allow for a connection assessment check to prevent approach and collision with NASA facilities; update control status data on the 18 SPCS website and the Space-Track.org as soon as the loss of control of Starlink is reported; conduct orbital flights to avoid approaching the ISS; collaborate on the development of an alternative method of ephemeris delivery to ensure reliability if Space-Track.org is unavailable; notify NASA of changes in the Starlink connection assessment that have a direct impact on NASA; use orbits for Starlink launch that

are not less than 5 km above the ISS apogee or perigee; and provide NASA with the results of a profile analysis of ways to reduce the photometric brightness of the satellite for use in developing recommendations to the Agency. In general, this Agreement aims to form a mutually beneficial foundation for effective cooperation of the NCAA (2021).

A similar agreement was concluded between NASA and Blue Origin USAA (2022) and is intended to ensure the development and testing of key technologies for future space systems. This interaction involves the promotion of commercial space activities by providing Blue Origin with access to NASA resources (in particular, equipment, technical capabilities, and software) (provided for in Article 2 of the USAA). Article 5 of the USAA stipulates that the parties must independently finance their expenses since the implementation of space activities under this Agreement depends on the availability of funds from both parties.

Article 8 of the USAA (2022) is of great importance, outlining the responsibility of the participants and providing for a mutual waiver of claims. Thus, Blue Origin undertakes not to file claims against NASA and its affiliates in the event of bodily injury, death, damage or loss arising from the performance of activities conducted under the agreement, including negligence, but excluding cases of intentional misconduct. Thus, both private companies have a comprehensive legal framework governing their activities in addition to the above-mentioned regulations, the companies are subject to the fundamental space treaties.

Kazakhstan's experience in the space sector: Legal framework and space activities. The main regulatory act in the space industry of Kazakhstan is the Law of the Republic of Kazakhstan No. 528-IV (2012) Article 2 of this Law establishes that the legislative framework of Kazakhstan on space activities consists directly of this Law and the Constitution of Kazakhstan. At the same time, part 2 of Article 2 of the Law of the Republic of Kazakhstan No. 528-IV provides for the hierarchy of ratified international treaties in this area over the Law of the Republic of Kazakhstan No. 528-IV. Article 4 of the Law of the Republic of Kazakhstan No. 528-IV defines the main areas of space activities carried out in Kazakhstan, including: development and implementation of space objects; remote observation of the Earth from space; launching space objects into orbit; scientific exploration of near-Earth space, the solar system and solar-terrestrial interactions; space-time and air navigation services; development and commissioning of satellite communication systems; conducting scientific research and development; ensuring Kazakhstan's cooperation with other states in the peaceful exploration and use of space; promoting the development of the domestic market of commercial space services and their entry into the international market.

Article 5 of the Law of the Republic of Kazakhstan No. 528-IV (2012) contains a list of types of space activities aimed at the formation and use of space infrastructure facilities in the Republic of Kazakhstan (RK). These types of activities include:

1. Conducting research and scientific and technical development.
2. Design and technical development.
3. Manufacturing and testing of experimental, prototype, developmental and commercial spacecraft.
4. Operation, maintenance and modernisation of spacecraft.
5. Operation of space facilities and technical equipment.
6. Supply of space services to end users.

Article 9 of the Law of the Republic of Kazakhstan No. 528-IV (2012), which defines the powers of the competent authority in the space sector, is of great importance. Thus, the competent authority in the field of space activities is responsible for the formation and implementation of the state strategy for space activities. In addition, the authority manages the implementation of projects and programmes, approves decisions on the launch of space objects, and approves the procedure for selecting candidates for the position of astronaut. It also deals with licensing in this area, exercises state control and maintains a register of space objects.

Section 5 of the Law of the Republic of Kazakhstan No. 528-IV (2012), which deals with the issue of safety of space activities, is of particular importance in the Outer Space Treaty. Thus, Article 27 of the Law of the Republic of Kazakhstan No. 528-IV refers to the importance of ensuring the safety of human health and the environment during space activities. Article 29 of the Law of the Republic of Kazakhstan No. 528-IV defines clear prohibitions in the implementation of space industry policy, including: launching into orbit and placing weapons of mass destruction in outer space; conducting space activities that pose a direct threat to human health and life; violate the norms and standards of international law in the field of space pollution; use space assets and celestial bodies to cause environmentally harmful effects; and in the event of a potential threat of harm during certain space activities, it is established that such actions should be limited. In general, this legal act is designed to balance national needs, security, defence and cooperation in the international arena. At the same time, it promotes investment activity and guarantees safety and compliance with environmental standards.

Notably, the role of international treaties in the field of space activities for the legislation of Kazakhstan, as the state ensures the consistency of provisions with international law by implementing them. Part 2 of Article 2 of the Law of the Republic of Kazakhstan No. 528-IV (2012) establishes the hierarchy of international law over the national legislation of the Republic of Kazakhstan, thus, the state establishes that space activities should be carried out following the principles and rules defined by international law. Thus, the said implementation of the provisions can be traced in Article 11 of the Law of the Republic of Kazakhstan No. 528-IV, which establishes the obligation to register space objects, which, in turn, is provided for in Article 8 of the OST (1966), which establishes the jurisdiction of the state and its control over the object launched into space in case of its registration in the relevant state. Moreover, this obligation to register objects launched into space is established in Article 2 of the RC (1974).

To a certain extent, Kazakhstan has implemented the provisions of Articles 2 and 3 of the LC (1971) in Article 27 of the Law of the Republic of Kazakhstan No. 528-IV (2012), which establishes the obligation to prosecute and compensate for damage caused by a space object and space activities in general. While the RA (1967) does not directly appear in Kazakhstan's space legislation, its principles of cooperation and mutual assistance in the rescue of astronauts and the return of space objects are generally consistent with Kazakhstan's obligations in the field of international cooperation in space activities. This is evidenced by Kazakhstan's participation in international treaties and membership in the

UN Committee on the Peaceful Uses of Outer Space. Thus, Kazakhstan's space legislation is based on the implemented principles and provisions of the fundamental international treaties on outer space activities, while ensuring the hierarchy of international law in case of contradictions. Such harmonisation of legislation guarantees effective cooperation and involvement of Kazakhstan in global space activities on the principles of cooperation and responsibility.

The National Space Agency of Kazakhstan (Kazcosmos) is central in ensuring space activities in Kazakhstan, which was established based on a constituent document signed by the President of Kazakhstan in 2005 (officially in 2007). This establishment and further rapid development were facilitated by the events of 2006, which laid a solid foundation for Kazakhstan's space activities with the launch of KazSat-1. The original purpose of Kazcosmos was to unite efforts to implement the policy of the Republic of Kazakhstan and coordinate measures for the development of outer space. This process included the development of the domestic space industry through the establishment of long-term strategic partnerships with international institutions and states (in particular, with Airbus Defence and Space) (Chukalova *et al.,* 2018; Tiberghien, 2024).

Currently, the functions of Kazkosmos are performed by the Aerospace Committee of the Ministry of Digital Development, Innovation and Aerospace Industry of the Republic of Kazakhstan. In its activities, Kazcosmos relies on the regulatory framework governing space activities in Kazakhstan. This applies to legislation in the field of state regulation and control of space activities of the Space Code (Article 9 of the Law of the Republic of Kazakhstan No. 528-IV (2012)), compliance with safety standards and requirements (Section 5 of the Law of the Republic of Kazakhstan No. 528-IV (2012)), and compliance with international treaties (provided for in Article 3 of the Space Code of the Law of the Republic of Kazakhstan No. 528-IV). In addition, the Agency actively develops international cooperation for the effective development of outer space.

The Committee is responsible for implementing several projects, such as the launch of KazSat satellites providing communications services and the launch of KazEOSat for Earth monitoring. Kazcosmos actively cooperates with foreign partners to build space infrastructure, such as the Baikonur Cosmodrome and participates in environmental protection initiatives in partnership with Russia (Bekus & Medeuov, 2022; Antonsen *et al.,* 2023). The agency specialises in training personnel and expanding the scientific potential of Kazakhstan's space industry. The agency also contributes to the state's priorities through strategic partnerships and the reconstruction of existing space infrastructure facilities (Bekus & Medeuov, 2022).

Cazcosmos is central in implementing government policy and managing space projects, including the creation of satellite communications systems and infrastructure development. Due to the favourable location of the Baikonur Cosmodrome, the Republic of Kazakhstan's position in the global space environment is strengthening. At the same time, ongoing legal development is helping to expand the potential of the space industry.

Discussion

In the rapidly developing field of space exploration, the legal framework plays a crucial role in governing the activities of both international agencies and private companies. The international space law framework, which is primarily based on the OST and LC, establishes fundamental principles. In particular, the non-appropriation of outer space by any state and ensuring liability for damage caused by space objects. The national legislation of countries such as Kazakhstan complements this framework and regulates domestic activities in space while following international norms. Based on these principles, agencies such as NASA, ESA, and Kazcosmos operate to ensure compliance with international obligations and national legislation of their respective countries. At the same time, private companies such as SpaceX and Blue Origin are required to overcome the obstacles of the regulatory landscape to provide innovative space services while maintaining compliance with legal norms. As these companies push the boundaries of space exploration, it is increasingly relevant for the sustainable growth of the sector to define their legal obligations.

E.L. Antonsen *et al.* (2023) addressed the improvement of NASA's approaches to assessing and minimising risk factors that affect human health and performance in space missions. The authors revised the concept of risk management to update it to meet the changing priorities of missions, including Mars and Lunar missions. The researchers found that to effectively communicate risks to mission participants, a systematic approach based on tools such as cause-and-effect diagrams is required. The goal of this approach is to ensure that new data obtained as a result of research is incorporated into risk assessments, which will help to make informed decisions to ensure the safety of astronauts.

While the focus of both studies is on ensuring safety through the management of crew health hazards and through compliance with legislation, both differ significantly in scope and methodology (Antonsen *et al.,* 2023). Regardless of these differences, however, both studies emphasise the need for a systemic approach to overcome challenges in the space domain. In general, the study by E.L. Antonsen *et al.* (2023) is consistent with the present study, as it emphasises the importance of developing a structured framework to address the complex challenges of space exploration. This consistency is expressed in the emphasis of both studies on the use of system analysis as a tool for effectively achieving the set goals.

J. Tapio and A. Soucek (2022) examined how ESA influences national legislation in the space sector within the framework of international partnership. Using the example of Finland, the authors examined the peculiarities of interaction between interagency structures and state administrations. In particular, the researchers emphasised that international instruments make national legislation more important, as they strengthen the capacity of the legislative and executive branches of government. The authors noted the role of ESA in stimulating the competitiveness of the space industry in its member states.

Both studies aimed at analysing the regulatory framework in the field of space activities, however, while J. Tapio and A. Soucek (2022) focused on the impact of the ESA concerning national legislation, this study covers a wider range of agencies (NASA, ESA, Kazcosmos) and private companies (SpaceX, Blue Origin). In addition, this study also considers the specifics of Kazakhstan's space legislation. Both studies emphasise that international cooperation is key to the development of space law. The emphasis on how the international legal framework contributes to the development of national

space exploration legislation is also common. This coherence is expressed in the mutual recognition of international law and the influence of its space standards on national legislation.

N. Bekus and Z. Medeuov (2024) analysed the challenges and prospects facing Kazakhstan on the way to developing the space technology sector. The authors highlighted how Kazakhstan navigates its position as a semi-peripheral country in the global space industry. At the same time, the researchers noted that, despite significant successes, Kazakhstan faces problems related to limited resources and international competition. Authors emphasised the importance of establishing strategic partnerships to address these challenges.

Compared to the present study, both share a common interest in defining Kazakhstan's role in the global space environment but differ in that their research focuses more on technological development than on legal regulation. Although both studies define Kazakhstan's strategic position because of its historical relationship with Russia (i.e., the Baikonur Cosmodrome), they approach this issue from different perspectives – technological and legal. The study by N. Bekus and M. Medeuov (2024) is consistent with this study, highlighting challenges that are also relevant when analysing the legal framework of Kazakhstan's space activities. It concerns the recognition of the need for effective technological development to ensure success in the international arena with the help of reliable legal support.

R.J. Lee (2024) analysed the application of international space law to the obligations in the field of rescue and relief for both private and commercial space actors. The author assessed the evolution of space rescue agreements, the challenges faced by private companies such as SpaceX and Blue Origin, and the prospects for the safety of human spaceflight. In general, the author pointed out that there are shortcomings in the legal framework regarding the liability of private actors in emergencies.

Both studies examine the legal framework governing space activities, but they differ in their specific focus. For instance, this study examines broader legal issues covering the activities of several agencies (in particular, NASA, ESA, and Kazcosmos), including the legislation of Kazakhstan. In contrast, the study by R.J. Lee (2024) provides a detailed look at the specifics of emergency rescue operations conducted by private companies. These studies share the common subject of the impact of international law on the activities of private companies, such as SpaceX, but they differ somewhat in their coverage. Moreover, both studies highlight the problem of applying international norms to rapidly developing private space companies. In general, the study by author is consistent with the present study, as it highlights similar issues related to the adaptation of the legal framework to the growing role of private companies in space exploration.

In their turn, D. Maraš and M. Dangubić (2022) studied the development of cooperation between government agencies and private companies in the US space sector. The authors found that such cooperation helped to transform the space industry, as along with government funding and control, the private sector brought innovation and efficiency. The researchers also drew attention to how NASA and other US government agencies are actively engaging with private companies such as SpaceX to achieve common goals in space exploration. This is indicative of a broader trend in which public-private cooperation is becoming increasingly important for the advancement of space technology (Uliutina, 2023).

The two studies, focus on the interaction between state institutions and private companies in the space sector, but this study goes beyond these issues by considering the international legal framework and specific legislation of Kazakhstan. While D. Maraš and M. Dangubić (2022) focused on US-based cooperation, this study offers an analysis of various international relations (including Kazakhstan). Despite the differences, both studies emphasise the importance of public-private cooperation to expand the capabilities of space technologies. In general, the study by D. Maraš and M. Dangubić is similar to this study, as it confirms the key role of cooperation in promoting innovation in the global space industry through the creation of an effective regulatory framework and strategic partnerships.

The results of the study showed that a regulatory framework is necessary to ensure the effective functioning of both international space agencies and private companies engaged in space activities. In addition to the legal framework, international cooperation in the space industry needs to be established, including interaction between the public and private sectors. This cooperation should be based on the principles of openness and mutual benefit to facilitate the exchange of technology and knowledge. It is also important to develop clear safety standards and ethical norms to govern activities in space, including the use of resources and environmental protection. Given the growing commercialisation of space, establishing an effective regulatory system is key to ensuring the sustainable development of the space industry.

Conclusions

The regulatory framework governing space activities is a complex and evolving system that is essential for regulating the activities of global space agencies and private space companies. In general, 5 key international treaties form the basis for space activities. OST is the basis for all other space treaties, providing for the guiding principles of space law (peaceful use of outer space, prohibition of appropriation of outer space objects, non-discrimination). RA regulates issues related to rescue in emergencies and establishes the importance of international cooperation in this regard. LC establishes provisions on the responsibility of states for causing damage to astronauts or space technologies of another state, in particular, provides for appropriate compensation. RC establishes the obligation of states to register their objects launched into space. MA defines space activities on the Moon (in particular, prohibits the deployment of nuclear weapons and military units on the Moon).

The study determined that cooperation between the private and public sectors involved in space activities is becoming increasingly important. Such partnerships increase efficiency and risk sharing, which helps to accelerate technological progress. Such alliances can ensure the availability and cost-effectiveness of space services. In particular, the combination of efforts allows for greater opportunities for space exploration and commercialisation, which benefits both the public and private sectors.

The activities of NASA, ESA and Kazcosmos are governed by the provisions of international space law, following the five main outer space treaties. In their activities, these space agencies and committee are guided by principles that encourage peaceful space exploration and prohibit the militarisation of outer space. In addition, their activities are regulated by national laws and regulations of their respective

countries, while adhering to special strategies and cooperation agreements. In turn, private companies such as SpaceX and Blue Origin are also subject to international space law and control by the regulatory authorities of their respective countries. In particular, the OST provision grants companies the right to conduct business in space, provided that the jurisdiction belongs to their country of origin. Companies are obliged to comply with the requirements of national legislation on the launch and operation of spacecraft. This ensures that commercial activities are consistent with international obligations and do not create obstacles to investment.

Further research could address the activities of space agencies and private entities in other countries, such as the UK, Germany, the Czech Republic, etc.

Acknowledgements

This research has been funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP22683782).

Conflict of interest

None.

References

[1] Abeyratne, R. (2011). The application of intellectual property rights to outer space activities. In *Space security law* (pp. 83-106). Heidelberg: Springer Berlin. doi: 10.1007/978-3-642-16702-7_8.

[2] Agreement Governing the Activities of States No. 34/68 "On the Moon and Other Celestial Bodies". (1979, December). Retrieved from https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/moon-agreement.html.

[3] Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space. (1967, December). Retrieved from https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/rescueagreement.html.

[4] Antonsen, E.L., Connell, E., Anton, W., Reynolds, R.J., Buckland, D.M., & Baalen, M.V. (2023). Updates to the NASA human system risk management process for space exploration. *Npj Microgravity*, 9, article number 72. doi: 10.1038/s41526-023-00305-z.

[5] Apakhayev, N., Omarova, A.B., Kussainov, S., Nurahmetova, G.G., Buribayev, Y.A., Khamzina, Z.A., Kuandykov, B., Tlepina, S.V., & Kala, N.S. (2018). Review on the outer space legislation: Problems and prospects. *Statute Law Review*, 39(3), 258-265. doi: 10.1093/slr/hmx010.

[6] Artemis Accords. Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes. (2020, October). Retrieved from https://www.nasa.gov/wp-content/uploads/2022/11/Artemis-Accords-signed-13Oct2020.pdf?emrc=67a6864ea0b03.

[7] Atkins, S. (2022). The commercialisation of outer space. How an international securities framework can be the launching pad for a global space economy. *International Corporate Rescue*, 19(3).

[8] Barikova, A. (2023). Discretion and electronic communications markets: O-RAN perspective. *Scientific Journal of the National Academy of Internal Affairs*, 28(3), 38-47. doi: 10.56215/naia-herald/3.2023.38.

[9] Bekus, N., & Medeuov, Z. (2022). *Emerging space power in Central Asia: Kazakhstan at the crossroad*. Retrieved from https://nepf.org.au/index.php/emerging-space-power-in-central-asia-kazakhstan-at-the-crossroad/.

[10] Bekus, N., & Medeuov, Z. (2024). Aspirations and challenges of space techno-science in global semi-peripheries. A view from Kazakhstan. *Science, Technology and Society*, 29(2), 322-342. doi: 10.1177/09717218231206585.

[11] Brady, P., & Orlinksi, J. (2022). An evaluation of the general public's perception of the commercialization of space. *Journal of Student Research*, 11(1). doi: 10.47611/jsrhs.v11i1.2380.

[12] Chudyk, N., & Vivchar, O. (2023). Strategy of strengthening the economic security of enterprises of network structures: Pragmatics and key vectors of development. *Law, Policy and Security*, 1(1), 55-67.

[13] Chukalova, R., Kakenova, Z., Kushpaeva, A., Alpeisov, A., & Kakenova, G. (2018). The role of Baikonur in the context of military-political cooperation between Kazakhstan and Russia. *Opcion*, 34(85), 551-581.

[14] Consonni, G., Rizz, M., & Herrera, F.D. (2023). *The outer space business: The impact of private actors on space governance*. Retrieved from https://mondointernazionale.org/focus-allegati/the-outer-space-business-the-impact-of-private-actors-on-space-governance.

[15] Convention for the establishment of a European Space Agency. (1975, May). Retrieved from https://treaties.un.org/doc/Publication/UNTS/Volume%201297/volume-1297-I-21524-English.pdf.

[16] Convention on International Liability for Damage Caused by Space Objects. (1971, November). Retrieved from https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/liability-convention.html.

[17] Convention on Registration of Objects Launched into Outer Space. (1974, November). Retrieved from https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/registration-convention.html.

[18] Fedonyuk, T.P., Galushchenko, O.M., Melnichuk, T.V., Zhukov, O.V., Vishnevskiy, D.O., Zymaroieva, A.A., & Hurelia, V.V. (2020). Prospects and main aspects of the gis-technologies application for monitoring of biodiversity (on the example of the Chornobyl radiation-ecological biosphere reserve). *Space Science and Technology*, 26(6), 75-93. doi: 10.15407/knit2020.06.075.

[19] Gangmeih, P., & Mishra, R.K. (2024). The relationship between outer space activities and intellectual property laws. *Educational Administration Theory and Practices*, 30(1), 741-748. doi: 10.53555/kuey.v30i1.5456.

[20] George, J. (2024). *The future of space exploration lies in space commercialization*. Retrieved from https://wired.me/science/space/space-commercialization-lucas-del-monte/.

[21] Hall, C. (2024). Accelerating space exploration: The confluence of tech & commercialization. *Amplify Update*, 37(4).

[22] Heitor, M., Cunha, M.P.E., Clegg, S., Sirage, E., & Oliveira, P. (2024). Beyond new space: Changing organizational forms, collaborative innovation and public and semi-public domains. *Space Policy*, 68, article number 101609. doi: 10.1016/j.spacepol.2023.101609.

[23] Inventions in space. (n.d.). Retrieved from https://www.wipo.int/en/web/patents/topics/outer-space.

[24] Jagota, N. (2023). *Legal dimensions of commercialisation of space*. New Delhi: Vivekananda international foundation.
[25] Kaneria, B., & Pandey, S. (2024). Interplay between technology and law in space exploration. *IOSR Journal of Environmental Science Toxicology and Food Technology*, 18(3), 31-46. doi: 10.9790/2402-1803013146.
[26] Khlystov, N., & Markovitz, G. (2024). *Space is booming. Here's how to embrace the $1.8 trillion opportunity*. Retrieved from https://www.weforum.org/stories/2024/04/space-economy-technology-invest-rocket-opportunity/.
[27] Konert, A., Balcerzak, T., Książek-Janik, E., & Yarushina, A. (2022). Legal framework for space exploration. Benefits and threats for the earth. *Transportation Research Procedia*, 65, 144-150. doi: 10.1016/j.trpro.2022.11.017.
[28] Law of the Republic of Kazakhstan No. 528-IV "On Space Activity". (2012, January). Retrieved from https://adilet.zan.kz/eng/docs/Z1200000528.
[29] Le Coze, J.-C. (2024). NASA, SpaceX, safety and (post) bureaucracy. Reinterrogating the past, challenging the present with H. Mccurdy. *Safety Science,* 177, article number 106599. doi: 10.1016/j.ssci.2024.106599.
[30] Lea, R. (2025). *Artemis Accords: What are they & which countries are involved?* Retrieved from https://www.space.com/artemis-accords-explained.
[31] Lee, R.J. (2024). Emergency assistance and rescue obligations for commercial and private spacefarers in the context of the history, present, and future of human spaceflight. In M.A. Pozza (Ed.), *Ascending to space: Critical perspectives from New Zealand and other Nations* (pp. 35-72). Singapore: Springer. doi: 10.1007/978-981-97-0714-0_3.
[32] Lindbergh, R. (2024). *Space resource extraction: Overview and issues for congress*. Retrieved from https://www.congress.gov/crs-product/R48144.
[33] Maraš, D., & Dangubić, M. (2022). Cooperation between government agencies and private companies in space: The case of the United States. *Astropolitics*, 20(2-3), 226-237. doi: 10.1080/14777622.2022.2146495.
[34] Mayrhofer, D.A. (2024). *Business adaptive strategies in crisis: In the context of SpaceX and the space debris crisis*. Lisbon: Catholic University of Portugal.
[35] McCurdy, H.E. (2002). Daniel S. Goldin's legacy at NASA. *Space Policy*, 18(2), 95-97. doi: 10.1016/s0265-9646(02)00012-7.
[36] McCurdy, H.E. (2013). Learning from history: Low-cost project innovation in the U.S. national aeronautics and space administration. *International Journal of Project Management*, 31(5), 705-711. doi: 10.1016/j.ijproman.2013.02.001.
[37] Moltz, J. (2019). The changing dynamics of twenty-first-century space power. *Journal of Strategic Security*, 12(1), 15-43. doi: 10.5038/1944-0472.12.1.1729.
[38] Momose, K., Weekes, T.R., & Eskridge, T.C. (2023). Human-centered design for spaceflight participant safety and experience: A case study of blue origin suborbital flight. *New Space*, 11(1). doi: 10.1089/space.2021.0029.
[39] National Aeronautics and Space Act of 1958. (1958, July). Retrieved from https://www.nasa.gov/history/national-aeronautics-and-space-act-of-1958-unamended/.
[40] Nonreimbursable Space Act Agreement between NASA and SpaceX for Flight Safety Coordination with NASA Assets. (2021, March). Retrieved from https://www.nasa.gov/wp-content/uploads/2015/01/nasa-spacex_starlink_agreement_final.pdf.
[41] Olivari, M., Jolly, C., & Undseth, M. (2021), *Space technology transfers and their commercialisation*. Paris: OECD Publishing. doi: 10.1787/0e78ff9f-en.
[42] Pallathadka, H., & Pallathadka, L.K. (2022). A detailed study of Space X vs. Blue Origin vs. Virgin Galactic and the future of space travel. *Integrated Journal for Research in Arts and Humanities*, 2(6), 195-201. doi: 10.55544/ijrah.2.6.26.
[43] Private companies are launching a new space race – here's what to expect. (n.d.). Retrieved from https://research.open.ac.uk/space-race.
[44] Ruhaeni, N., Aqimuddin, E.A., & Afriyadi, H. (2022). The commercialization of outer space under the Outer Space Treaty 1967 and its implementation on the development of space industry in Indonesia. In A. Rachmiatie, D. Ahamadi, I.J. Triwardhani, A. Satriani, Firmansyah, Alhamuddin & A.F. Sebayang (Eds.), *Proceedings of the 4th social and humanities research symposium* (pp. 422-427). Dordrecht: Atlantis Press. doi: 10.2991/assehr.k.220407.086.
[45] Salykov, A., Aimbetov, A., Yesmagulova, N., & Jussibaliyeva, A. (2024). Factors and trends in the development of the space industry in the context of the digitalization of the economy of the Republic of Kazakhstan. *Environment, Development and Sustainability*, 26, 6703-6718. doi: 10.1007/s10668-023-02983-x.
[46] Serikzhanova, A., Nurtazina, R., Serikzhanova, I., Bukharbay, B., & Taitorina, B. (2024). Evolving political cultures in Kazakhstan, Uzbekistan, and Kyrgyzstan: Trends and new paradigms. *Journal of Ethnic and Cultural Studies*, 11(3), 1-24. doi: 10.29333/ejecs/1914.
[47] Space commercialization: Promises & challenges. (n.d.). Retrieved from https://www.10eqs.com/white-papers/space-commercialization-promises-challenges/.
[48] Space Foundation Editorial Team. (2024). *The space report 2024 Q3 shows significant private workforce growth in Europe, a push for commercial space stations, and space force surpassing guardian recruiting goals*. Retrieved from https://www.spacefoundation.org/2024/10/22/the-space-report-2024-q3/.
[49] Space Stats. (n.d.). *Orbital launches in 2024*. Retrieved from https://spacestatsonline.com/launches/year/2024.
[50] Space technologies and applications. (n.d.). Retrieved from https://space4climateaction.unoosa.org/content/space-technologies-and-applications.
[51] Sylkina, S.M., Dosymbekova, M.S., Baytukaeva, D.U., Begzhan, A.M., & Toktybekov, T.A. (2015). Development of space activity or the Republic of Kazakhstan: History and modern (political and legal aspect). *Mediterranean Journal of Social Sciences,* 6(5), 392-398. doi: 10.5901/mjss.2015.v6n5s1p392.
[52] Tapio, J., & Soucek, A. (2022). The European Space Agency's contribution to National Space Law. In K. Karjalainen, I. Tornberg & A. Pursiainen (Eds.), *International actors and the formation of laws* (pp. 113-134). Cham: Springer. doi: 10.1007/978-3-030-98351-2_6.

[53] Tiberghien, G. (2024). Investigating space heritage interpretation for tourism development and heritage preservation at Baikonur cosmodrome, Kazakhstan. *Tourism Planning & Development*, 21(6), 773-794. doi: 10.1080/21568316.2024.2319145.

[54] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. (1966, December). Retrieved from https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html.

[55] U.S. Commercial Space Launch Competitiveness Act. (2015, December). Retrieved from https://www.congress.gov/bill/114th-congress/house-bill/2262/text.

[56] Uliutina, O. (2023). Information and communication technologies legislation for self-government bodies. *Law. Human. Environment*, 14(4), 66-78. doi: 10.31548/law/4.2023.66.

[57] Unfunded Space Act Agreement between the National Aeronautics and Space Administration and Blue Origin of 2022. (2022, November). Retrieved from https://www.nasa.gov/wp-content/uploads/static/saa/domestic/38798_22-22ACOFinal-0028-38798_Blue_Origin_Ghabchi.pdf.

[58] Usulor, C. (2023). Made in space: The legal protection of intellectual property in space. *SSRN*. doi: 10.2139/ssrn.4432810.

[59] Viterale, F. (2023). Transitioning to a new space age in the 21st century: A systemic-level approach. *Systems*, 11(5), article number 232. doi: 10.3390/systems11050232.

[60] Wang, C., & Wang, J. (2024). Legal regulation of commercial exploitation of outer space resources and China's countermeasures. *Beijing Law Review*, 15(3), 1040-1064. doi: 10.4236/blr.2024.153063.

[61] Zhao, Y. (2018). Space commercialization and the development of Space Law. *Oxford Research Encyclopedia of Planetary Science*. doi: 10.1093/acrefore/9780190647926.013.42.

Правовий аналіз діяльності світових космічних агентств та приватних компаній, що надають космічні послуги

Гульміра Ішкібаєва

Доктор філософії, науковий співробітник
Жетісуський університет ім. І. Жансугурова
040009, вул. Жансугурова, 187А, м. Талдикорган, Республіка Казахстан
https://orcid.org/0000-0002-7021-5627

Данія Нурмухан кизи

Доктор філософії, доцент
Жетісуський університет імені І. Жансугурова
040009, вул. Жансугурова, 187А, м. Талдикорган, Республіка Казахстан
https://orcid.org/0000-0003-3817-1975

Галим Телюєв

Доктор філософії, декан факультету права та економіки
Жетісуський університет імені І. Жансугурова
040009, вул. Жансугурова, 187А, м. Талдикорган, Республіка Казахстан
https://orcid.org/0000-0001-9575-5278

Дана Байтукаєва

Доктор філософії, старший викладач
Казахський національний університет імені аль-Фарабі
050040, просп. Аль-Фарабі, 75, м. Алмати, Республіка Казахстан
https://orcid.org/0000-0002-8564-7027

Анотація. Метою дослідження було проаналізувати міжнародне законодавство в космічній галузі та законодавство Республіки Казахстан, а також встановити правові засади діяльності приватних суб'єктів та міжнародних космічних агентств. Для ефективного вивчення теми в дослідженні були використані термінологічний, герменевтичний, порівняльний та історичний методи. У дослідженні охарактеризовано комерціалізацію космічних технологій та космосу в цілому, визначено сучасні проблеми та перспективи. Зокрема, досліджено питання трансферу знань та визначено ключову роль міжнародного співробітництва у цьому процесі. Також проаналізовано основну міжнародну нормативно-правову базу у сфері космічної діяльності. Встановлено правові засади діяльності провідних міжнародних космічних агентств (Національного управління з аеронавтики і дослідження космічного простору та Європейського космічного агентства), приватних компаній (Space Exploration Technologies Corporation і Blue Origin), а також космічного комітету Казахстану – Аерокосмічного комітету Міністерства цифрового розвитку, інновацій та аерокосмічної індустрії Республіки Казахстан. У дослідженні визначено керівні принципи діяльності державних і приватних інституцій, встановлені міжнародним космічним правом (дослідження космічного простору та використання його об'єктів у мирних цілях, заборона привласнення небесних тіл, недискримінація та ін.). У дослідженні підкреслено необхідність забезпечення міжнародного співробітництва. Це стосується співпраці між державним і приватним секторами в реалізації спільних космічних цілей і завдань, спрямованих на збільшення потенціалу космічних технологій. Дослідження також підкреслює важливість дотримання державами договорів про космічну діяльність, а також їх гармонізації з національними правовими актами

Ключові слова: орбітальні запуски; міжнародна нормативно-правова база; супутник; небесні тіла; комерціалізація технологій